STOEBE SP.

A CONTRIBUTION TO ITS ECOLOGY.

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This study has been considered as a matter of considerable importance in the grassland studies being carried out at the Botanical Research Station, Frankenwald, under the direction of Prof. John Phillips, University of the Witwatersrand. It is quite largely an investigation into the physiological-ecology of a grass community ; this is also true, ultimately, of those parts of the investigation, which at first sight lack this direct connection.

Communities of this Stoebe* cover a considerable area, in the aggregate, in the Transvaal, and being a woody shrub, dry, and even prickly except for a few months in the year, its general unpalatibility allows it to occupy ground, which would otherwise carry a certain amount of grazing. The shrub grows to a height of about two and a half feet, and, taking into consideration the area covered by all the side branches, it may have a diameter of six feet. In appearance it is ericoid, and apparently xerophytic.

In a consideration of the annual life cycle of this plant, it is as well to start at the time of seeding and germination, which constitute critical points. With regard to seeding, it appears from combined field observation and laboratory experiments, that the seeds require a high water content in the soil, for germination. Thus young seedlings will be found only after good rainy seasons. The most favourable water content for germination would be in the neighbourhood of 90% of the Maximum Water Retaining Capacity, that is, 27% of the oven dry weight. It must be added that this high figure was determined in a series, which was not very exact, but sufficiently so, to show the trend of the experiment. At the same time, it appears that seeds have no opportunity to germinate on even moderately covered ground ; hence young seedlings generally are found on such relatively open areas as old roads or fire-breaks. This may be the result of the operation of the necessity for this high water content.

The seed crop is very heavy. Germination of seeds a year old gave a rough average of 40% viability. Generally, the first germinations occurred in ten days. In one case, germination did not cease until the 64th day, among a set of seeds on a germinating dish. Germinative

* According to Mrs. M. R. Levyns (manuscript), probably a new species, allied to *S. cinerea* Thunb. The vernacular names are " Slangbos " or " Grijsbos."

capacity is destroyed by fire, and by heating in water to 75° C., while even heating in water to 50° C., lowered the germination to 15½%. Germination in the dark, with a comparatively small number of seeds gave a return of 47½%, but none of the seedlings, when potted, lived. Seeds planted in a pot, and watered from below, resulted in the growth of 22½% of the sowing; but with a much higher water content, about 37½% of the seeds have already got past the cotyledon stage. It was found possible to separate highly viable seeds from those not quite so highly viable, by leaving them in water. A selection of those that had sunk to the bottom of the dish gave a germination of 70%, while those that had remained on top, showed only 20%. After three days' soaking, however, the seeds which in the meantime had sunk to the bottom gave 52%, and while comparatively few remained on top, they showed a still lower figure—26½%. The conclusions that may be drawn from these observations is that the plant is spread by seed.

Very young seedlings have not been found in the field, but apparently this is so because they are not distinct or noticeable until they are about six months old. At the end of the year, the plant bears a single head of flowers, or perhaps three at the most. The anatomical aspect of growth presents some remarkable features, with regard to the formation of cambium. It seems that fresh rings of cambium are being formed continually. It appears that the plant becomes rapidly woody. Again, the holard exercises a marked influence on the growth increment. A sort of root-stock is present, and it is probable that it is used as a storage organ. The precise time of growth is uncertain, but it is probably during favourable periods between November and March, when the bushes are fresh and green. Seeds are ripe between April-May-June, depending on the season. After this the shrubs become dormant to some extent and turn greyish in colour, the leaves losing their temporary freshness.

Water content of Stoebe twigs ranges from 22-69% on fresh weight, and 28-224% on oven dry weight. A few figures from the period early May to early June, this year, show the water content, in relation to the ash, may vary, taking the ash weight as 1, from 13·5 to 42·5. Similarly, the dry weight may vary, with regard to the weight of ash, between 18·5 and 31·5, depending in both cases, on rains, which raise the soil water, then the water content of the plant, and then the ash weight, at which time the dry weight falls. After this period, the dry weight increases, and the other factors decrease, though not necessarily in proportion; that is, the ash, for instance, will still remain high.

Up till now it has not been possible to make a very accurate determination of transpiration, but it has been roughly determined by

oil potometer, against "Blackwood" (*Acacia melanoxylon* R.Br.). for comparison. It is very high. For this reason, holards under Stoebe communities are deceptive, especially when they are only at moderate depths, and taken as isolated examples. The high water loss is very distinct in its effects as seen after burning, when a distinct bare area is visible round each big bush.

A root-bisect has shown Stoebe going down five feet. This probably is due to the loose sandy nature of the soil, which in the first place, permitted of such growth ; and in the second place, was probably necessary because the water did not remain in the upper levels. On the other hand, Stoebe has been found growing on "Ouklip", (Iron sesquioxide), with roots at about a depth of two feet below the surface, and many laterals. It might be noted that large plants, on being removed from the site of growth in the moist and cool month of December, 1933, wilted perceptibly, and would not grow after being transplanted. Further, it must be added that Stoebe plants have been found growing on soils which contained a large amount of clay, and showed M.W.R.C.'s 50-77%, but that this particular site was well watered by natural drainage. A comparison of roots among a few of the co-dominants of Stoebe, as they are found on Frankenwald, show *Eragrostis chalcantha*, with nearly all its roots in the first 6-12 inches ; *Elionurus argenteus*, with about half in the first foot, about half extending towards 18 inches, and a few almost to 2 feet ; *Tristachya hispida*, less important, mostly in six inches, and a few to 1½ feet. In the first place, as noted already, Stoebe is seasonal and rhythmic, but, unlike its competitors, it does not flower till late, about April, whereas the grasses mentioned above flower in late November-December. Some grasses, like *Cymbopogon plurinodis*, flower about April. In Cymbopogon, the roots are mostly laterals, at depths of 1-2 feet. It must be mentioned that only one example of each of the above is available, so that they may not be typical. This work seems to suggest that the co-dominants, with their rather shallow rooting, receive the benefit of the first rain, and thus grow and flower, and that it is only much later in the season—when the pressure of competition has eased—that Stoebe is able to perform these functions. These facts also suggest that any agency tending to interfere with, or even remove the grasses, would give Stoebe an easier existence, and further, that if no such interference does take place, the further growth of the grass cover may eventually react unfavourably on the bush.

It may be noted, that in testing grass seeds, germination was low, 6-7% for *Elionurus argenteus*, and about 25% for *Eragrostis chalcantha*. These figures are not worth much, as only a small number of seeds could be tested, and a number of tests proved negative. Nevertheless, the

indications are that germinative capacity in this type of grass is not high.

As the bush regenerates from seed, clearing has been found very successful. Firing, on the other hand, only stimulates the buds, which are situated on the stock, and at the base of each main stem. At no time of the year is firing successful. Furthermore it must be noted that it is not merely veld fires which are referred to here, but "burning-back" when dried grass and wood are piled round each bush, after the preliminary fire; even this extra heat does not kill the dormant buds, except in a small percentage of cases.

Poisoning has also been tried out, as a method of eradication. Arsenic pentoxide, potassium chlorate, and sodium chlorate have been tried. Sodium chlorate is the most successful, and the most easily handled. Solutions of various strengths, from $2\frac{1}{2}$-10% have been tried. Either the foliage was sprayed, or the butt of the plant. Both methods were equally successful. A gallon of the solution—in all strengths—was used for every fifteen plants. Whether or not the effect is permanent yet remains to be seen.

It is not possible, at the moment, to say very much about the typical physical conditions which form the environment of this plant, if there are any typical physical factors. This is not so much as regards the climatic features, but the edaphic, which are more liable to be modified, and more directly modified by the plant. A preliminary investigation suggests that the soil would be of a type which definitely is impoverished, and that this would be so, because it has been overgrazed. Detailed reconnaissance shows a record of occurrence for Stoebe, twice as great on grazed areas, as on ungrazed. By "grazed" is meant fairly heavy, and rather permanent stocking Annual firing for instance, will not bring in the plant and this is apparently so even when the firing is continued over a long period. This may be because seeds are destroyed, but probably not, considering the time of firing. Overgrazing, on the other hand, does lead to the appearance of Stoebe, probably because definite denudation takes place, after the plants in existence have been roughly handled. Water content does not appear to be important at this point, except as regards germination. That is to say, a soil where Stoebe is not existent will show much the same holard as a soil where Stoebe is quite heavy, and this may be so for different rock formations within a short distance of each other. On a soil which is naturally rather rich, over-grazing may not tend to denude the ground of vegetation, as happens on a poor quartz soil. Probably the soil under a Stoebe community will be rather acid, because the soil is of a type that permitted leaching, and leaching is probably a bigger factor than the presence

or absence merely of carbonates or lime. All the possible factors, M.W.R.C. values, pH values, holards, carbonates and the physical structure of the soil are so intimately related, that it is difficult to separate them. A few tests have shown absence of nitrates and of ammonium salts from both Stoebe and non-Stoebe soils, but the organic matter is rather higher in the latter than in the former. The bacterial population does not appear to be very great in either of the two types of soil, though it may be considered slightly greater in non-Stoebe soils, which, while showing pH values of from 6·67-7·06 are more suited to bacterial growth than the Stoebe soils, which ranged from 5·12-5·56.

In conclusion, I wish to acknowledge, and to thank Prof. J. F. V. Phillips, for his constant supervision of the whole of this investigation ; Dr. E. M. Young, for her generous assistance with the anatomical work (which is yet unfinished), and many other points in this work ; Dr. B. Segal, for determination of the pH values mentioned above, and also assistance and advice ; Mr. T. Barenbrug for his method of germination of the seeds ; Mr. Murray and Mr. Glover, for the use of their records, some of which are not yet published.

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